Raman Spectroscopy

Raman spectroscopy is primarily a technique for qualitative characterization of solids, liquids, and solutions. Raman spectra may reveal structural information about molecules. It complements information derived from infrared spectroscopy and, in addition, is applicable to aqueous solutions. Quantitative measurement of major molecular constituents is also possible in simple mixtures.

Principle of Technique

Samples are illuminated with a 15 mW, 488-nm laser beam. Using a double monochromator, a spectrum is obtained of the scattered, wavelength-shifted photons at a 90° angle to the laser beam. The frequencies of the Raman-scattered light (about 200 to 5000 cm^{-1}) are characteristic of the internal vibrations of the molecules and are related to the same energy levels as in infrared spectroscopy. Raman differs from infrared in that it detects changes in polarizability rather than dipole moment changes as a molecule vibrates.

Samples

Form. Solids, liquids, or solutions can be analyzed.

Size. The minimum size for liquids is 0.1 mL and for solids (powders), the minimum is 50 mg for capillary cell analysis.

Preparation. Samples can be analyzed as received or after particle size reduction.

Limitations

The instrument requires concentrations greater than 1 to 5% depending upon the analyte. Sample fluorescence or absorption near 488 nm may prohibit Raman characterization. Accuracy and precision in quantitative analysis is about ±5%, relative to the concentration measured.

Estimated Analysis Time

Each sample requires 1 to 8 h. Additional time may be needed to interpret spectra.

Capabilities of Related Techniques

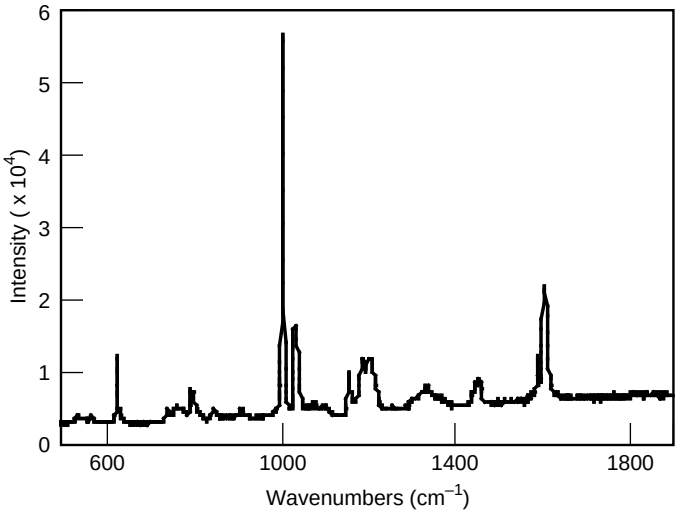
Infrared spectroscopy yields similar qualitative and quantitative information but it is not applicable to aqueous solutions.

UV-visible spectrophotometry can be used in rather similar ways to Raman spectroscopy for compound identification and for quantitative analysis.

Nuclear magnetic resonance spectroscopy may yield more detailed structural information about particular compounds, especially those containing protons.

Examples of Applications

- Determination of molecules and ions in aqueous solution.
- Qualitative identification of organic and inorganic compounds.
- Studies of structure and conformation of organic compounds.
- Structural and impurity analysis of polymers.



In Raman spectroscopy, optics are aligned and resolution is routinely monitored by taking polystyrene spectra.

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